EFM8 Sleepy Bee Family
EFM8SB2-SLSTK2011A User Guide

The EFM8SB2-SLSTK2011A is an excellent starting point to get familiar with the EFM8 EFM8SB2 Sleepy Bee microcontrollers.

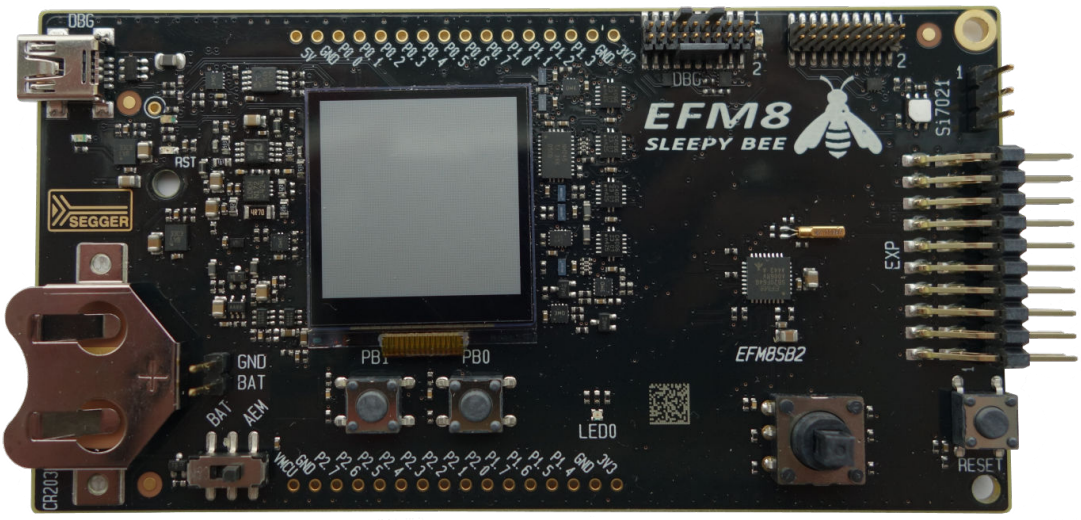
The kit contains sensors and peripherals demonstrating some of the MCU's many capabilities. The kit can also serve as a starting point for application development.

The kit includes:

- EFM8SB2 Sleepy Bee Starter Kit Board
- 1 x CR2032 battery
- Getting Started card
- 1 x mini USB cable

KEY FEATURES

- EFM8SB20F64G MCU with 64 KB Flash and 4 KB RAM.
- 20-pin expansion header.
- Breakout pads for easy access to I/O pins.
- Power sources include USB and CR2032 battery.
- 2 user buttons, 1 tri-color LED.
- 8-direction joystick.
- Silicon Labs Si7021 Humidity and Temperature Sensor.
- 32 kHz crystal for the RTC.
- Ultra low power 128x128 pixel Memory-LCD.



1. Getting Started

Hardware

To set up the hardware for the EFM8SB2-SLSTK2011A kit:

1. Provide power to the board by connecting the DBG USB connector to the PC using the provided USB cable.
2. Move the switch to the AEM position.

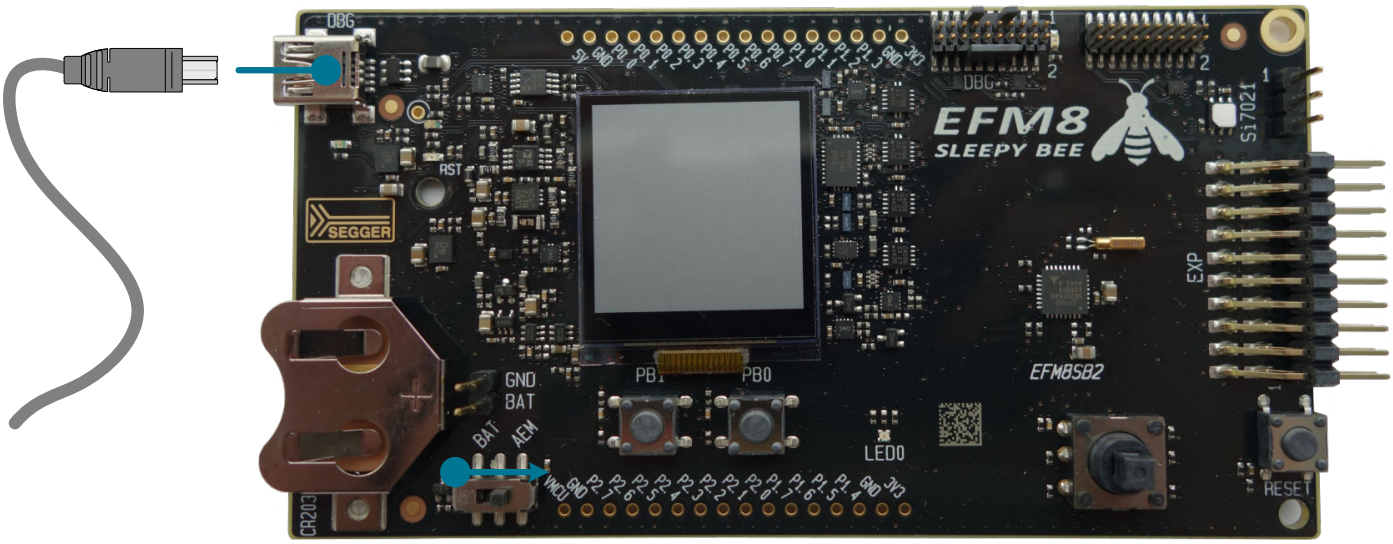


Figure 1.1. Hardware Setup

Software

The first step to get started with your new EFM8SB2-SLSTK2011A is to go to

http://www.silabs.com/simplicity

The Simplicity Studio software package contains all the tools, drivers, software examples and documentation needed to use the EFM8SB2 Starter Kit. The board comes pre-loaded with a default application, Clock, to play with while the software downloads.

After downloading the latest version of Simplicity Studio and installing using the [**Full**] or [**EFM8 / C8051 8-bit**] options:

1. Click the [**Refresh detected hardware**] button and select the EFM8SB2 Sleepy Bee Starter Kit Board under [**Detected Hardware**].
2. Click the [**Demos**] tile under [**Tools**] to load the available demos.
3. Click the [**Rainbow Blinky**] demo and click [**Start**] to download and run the demo.

Additional demos showcasing the various features of the EFM8 are also available under the same tile in Simplicity Studio.

2. Kit Block Diagram

An overview of the EFM8SB2 Starter Kit is shown in the figure below.

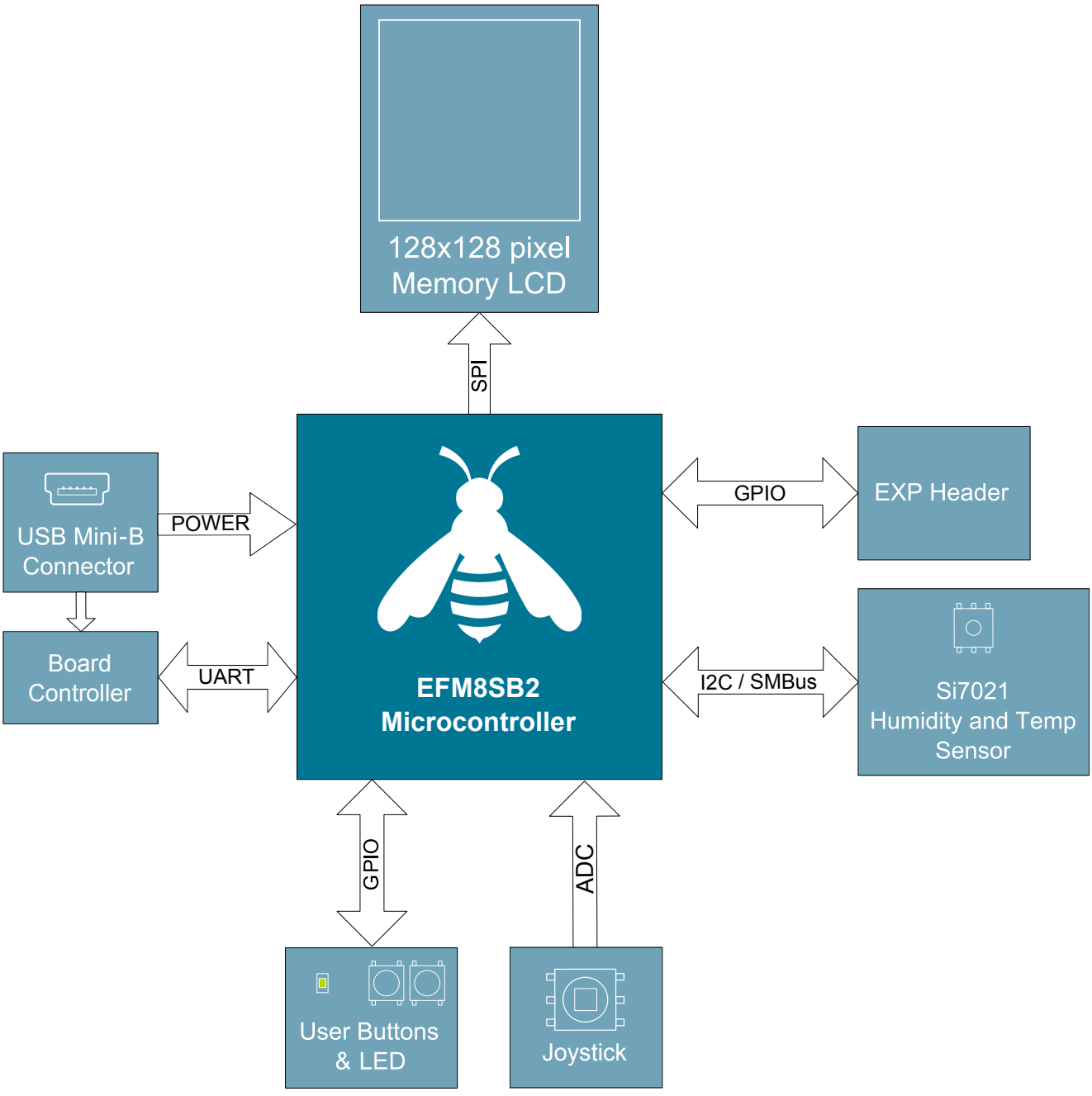


Figure 2.1. EFM8SB2-SLSTK2011A Block Diagram

3. Kit Hardware Layout

The layout of the EFM8SB2 Starter Kit is shown below.

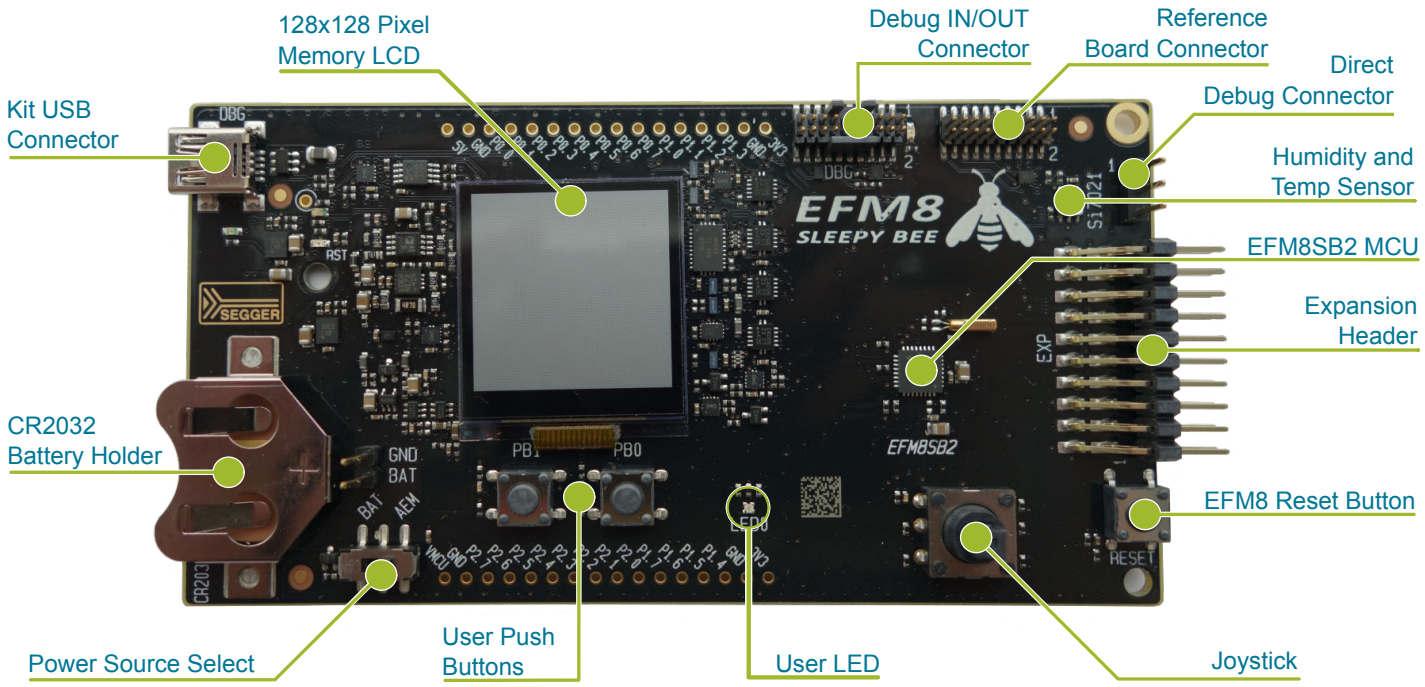


Figure 3.1. EFM8SB2-SLSTK2011A hardware layout

The EFM8 device on the kit is connected to several peripherals. The table below shows all of the external connections to the MCU.

Table 3.1. Kit MCU Connections

MCU Port Pin	Port Pin Assigned Function	Primary Board Connection	Secondary Board Connection	Expansion Port Connection (EXP)
P0.0	VREF	VREF Caps		
P0.1	AGND			
P0.2	Port Match Input	Push Button 0 (PB0)		
P0.3	Port Match Input	Push Button 1 (PB1)		
P0.4	UART0 TX	BC - UART_TX		EXP12
P0.5	UART0 RX	BC - UART_RX		EXP14
P0.6	SMBus0 SDA	I2C SDA		EXP16
P0.7	SMBus0 SCL	I2C SCL		EXP15
P1.0	SPI1 SCK	DISP - SPI CLK	SPI CLK	EXP8
P1.1	SPI1 MISO		SPI MISO	EXP6
P1.2	SPI1 MOSI	DISP - SPI MOSI	SPI MOSI	EXP4
P1.3	SPI1 NSS		SPI CS	EXP10
P1.4	GPIO	BC - Enable		
P1.5	GPIO	DISP - SPI CS		

MCU Port Pin	Port Pin Assigned Function	Primary Board Connection	Secondary Board Connection	Expansion Port Connection (EXP)
P1.6	GPIO			EXP3
P1.7	ADC / CMP	Joystick		
P2.0	PCA0 CEX0	RGB LED0		EXP5
P2.1	PCA0 CEX1	RGB LED1		EXP7
P2.2	PCA0 CEX2	RGB LED2		EXP9
P2.3	ADC			EXP11
P2.4	Timer	BC - REFCLK		
P2.5	GPIO			EXP13
P2.6	GPIO	DISP - Enable		
P2.7 / C2D	GPIO / C2D (for debug)	Debug - C2D	DISP - Enable	

4. Power Supply and Reset

4.1 MCU Power Selection

The EFM8SB2 Sleepy Bee MCU on the EFM8SB2-SLSTK2011A is designed to be powered by three different sources:

- Through the on-board debugger.
- By a 3 V Battery.
- An externally supplied power source.

Selecting the power source is done with the slide switch in the lower left corner of the board. The figure shows how the different power sources can be selected with the slide switch.

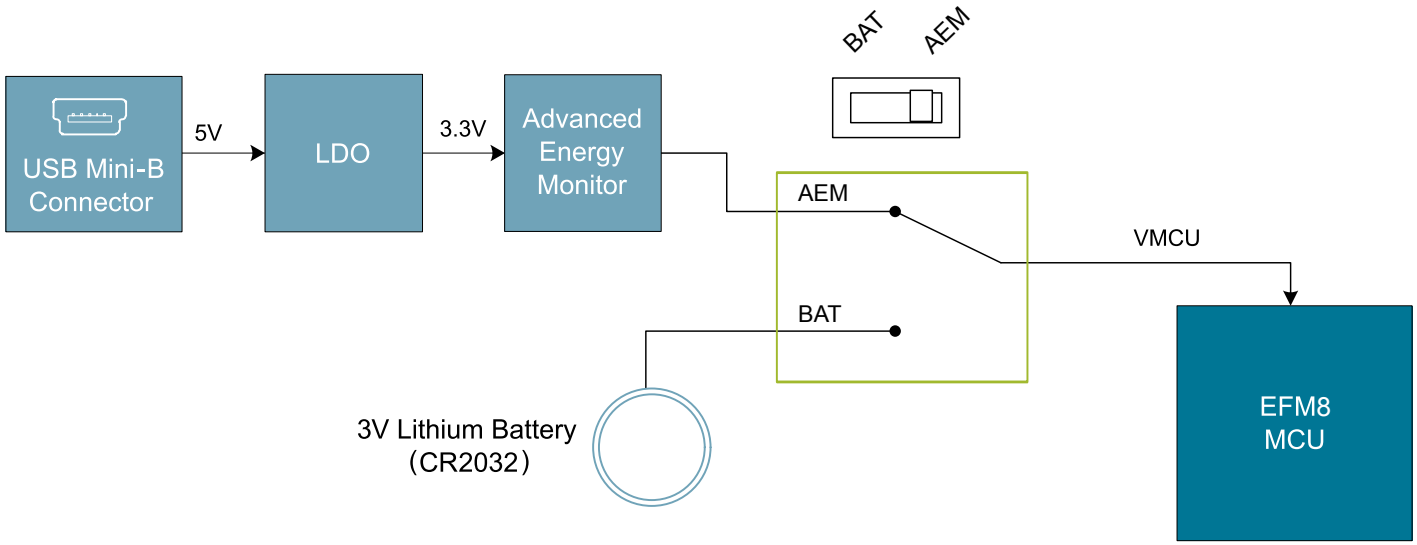


Figure 4.1. EFM8SB2-SLSTK2011A Power Switch

With the switch in the *AEM* position, an on-board low noise LDO with a fixed output voltage of 3.3 V is used to power the MCU. This LDO is powered from the "J-Link" USB cable.

With the switch in the *BAT* position, a 20 mm coin cell battery in the CR2032 socket can be used to power the device. The device can also be powered from an external power supply using the VMCU and GND pins on the expansion header.

4.2 MCU Reset

The EFM8 MCU can be reset by a few different sources:

- The RESET button.
- An external debugger by pulling the RSTb pin low.

5. Peripherals

The starter kit has a set of peripherals that showcase some of the features of the EFM8 EFM8SB2 Sleepy Bee microcontroller.

Be aware that most EFM8 I/O routed to peripherals are also routed to the breakout pads. This must be taken into consideration when using the breakout pads for your application.

5.1 Push Buttons and LEDs

The kit has two user push buttons. They are connected to the EFM8, and are debounced by RC filters with a time constant of 1 ms. The buttons are connected to pins P0.2 and P0.3.

In addition to the two push buttons, the kit also features a tri-color LED that is controlled by EFM8 GPIO. The LED is connected to pins P2.0, P2.1, and P2.2 in an active-low configuration.

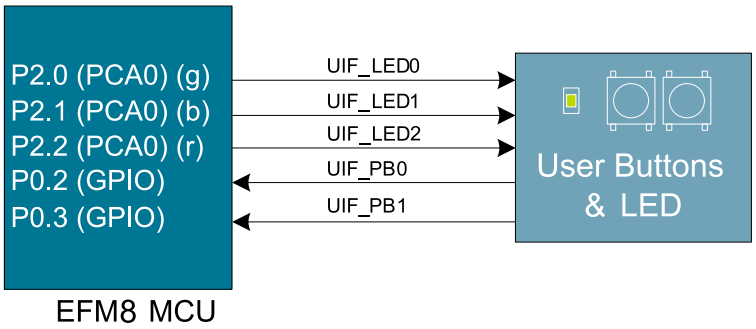


Figure 5.1. Buttons/LEDs

5.2 Joystick

The kit has an analog joystick with 8 measureable positions. This joystick is connected to the EFM8 on the P1.7 pin and uses different resistor values to create voltages measurable by the ADC0.

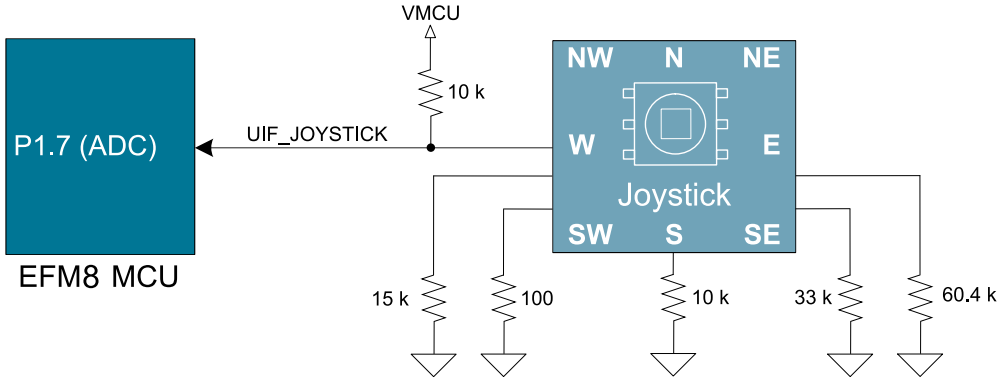


Figure 5.2. Joystick

Table 5.1. Joystick Resistor Combinations

Direction	Resistors Combinations (kohm)	Expected UIF_JOYSTICK Voltage (V)[1]
Center press	$\frac{0.1}{0.1 + 10}$	0.033
Up (N)	$\frac{60.4}{60.4 + 10}$	2.831
Up-Right (NE)	$\frac{(N \mathbin{//} E)}{(N \mathbin{//} E) + 10} = \frac{21.34}{21.34 + 10}$	2.247
Right (E)	$\frac{33}{33 + 10}$	2.533
Down-Right (SE)	$\frac{(S \mathbin{//} E)}{(S \mathbin{//} E) + 10} = \frac{7.67}{7.67 + 10}$	1.433
Down (S)	$\frac{10}{10 + 10}$	1.650
Down-Left (SW)	$\frac{(S \mathbin{//} W)}{(S \mathbin{//} W) + 10} = \frac{6}{6 + 10}$	1.238
Left (W)	$\frac{15}{15 + 10}$	1.980
Up-Left (NW)	$\frac{(N \mathbin{//} W)}{(N \mathbin{//} W) + 10} = \frac{12.01}{12.01 + 10}$	1.801

Note:
1. These calculated values assume a VMCU of 3.3 V.

5.3 Memory LCD-TFT Display

A 1.28-inch SHARP Memory LCD-TFT has been added to the board to enable interactive applications to be developed. The display has a high resolution of 128 by 128 pixels and consumes very little power. It is a reflective monochrome display, so each pixel can only be light or dark, and no backlight is needed in normal daylight conditions.

The display interface consists of an SPI-compatible serial interface and some extra control signals. Data are sent to the display one line (128 bits) at a time.

The Memory LCD-TFT display is shared with the kit Board Controller, allowing the Board Controller application to display useful information when the user application is not using the display. The EFM8 MCU always controls ownership of the display using the EFM_DISP_ENABLE signal:

- 0: The Board Controller has control of the display.
- 1: The user application (EFM8) has control of the display.

Data are clocked in on EFM_DISP_MOSI (P1.2) when EFM_DISP_CS (P1.5) is high, and the clock is sent on EFM_DISP_SCLK (P1.0). The maximum supported clock speed is 1 MHz.

Please refer to the display application information for details on driving the display:

http://www.sharpmemorylcd.com/1-28-inch-memory-lcd.html

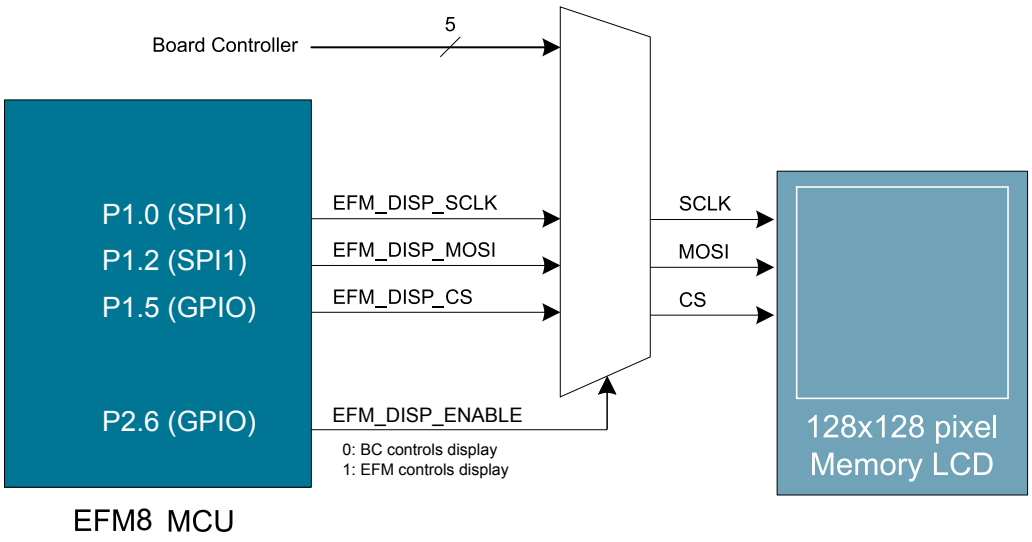


Figure 5.3. 128x128 Pixel Memory LCD

5.4 Humidity and Temperature Sensor

The EFM8SB2-SLSTK2011A board includes a Silicon Labs Si7021 humidity and temperature sensor to enable datalogging applications. The EFM8 MCU communicates with this sensor over the I2C / SMBus hardware interface.

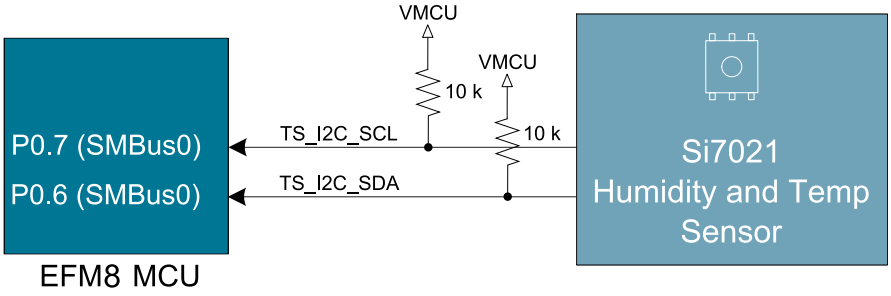


Figure 5.4. Humidity and Temperature Sensor

5.5 32 kHz Crystal

The kit has a 32 kHz crystal connected to the RTC crystal pins on the EFM8 MCU. This crystal enables the low power modes on the MCU that utilize the RTC.

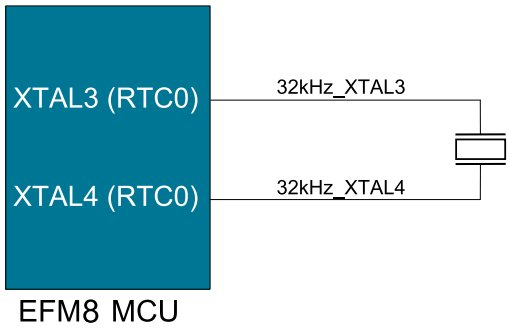


Figure 5.5. 32 kHz Crystal

6. Connectors

6.1 Breakout pads

Many of the EFM8's pins are routed out to "breakout pads" at the top and bottom edges of the kit. A 2.54 mm pitch pin header can be soldered in for easy access to these pins. Most I/O pins are available, with the exception of pins used to drive the LCD.
Note: Some of the breakout pads are shared by on-board EFM peripherals. The schematic must be consulted to make sure that it is acceptable to use a shared pin in your application.

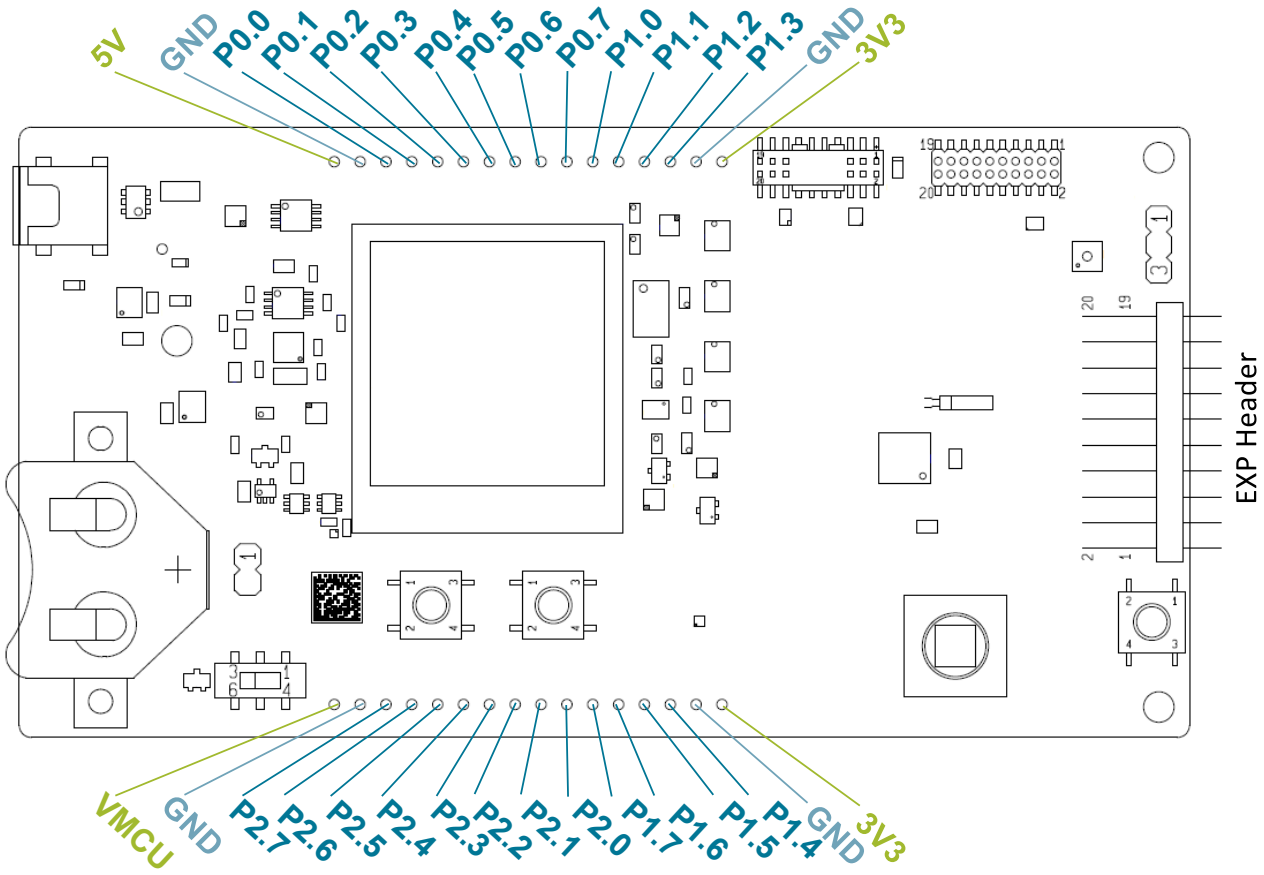


Figure 6.1. Breakout pads and Expansion Header

6.2 Expansion header

On the right hand side of the board an angled 20-pin expansion header is provided to allow connection of peripherals or plugin boards. The connecter contains a number of I/O pins that can be used with most of the EFM8SB2 Sleepy Bee's features. Additionally, the VMCU, 3V3 and 5V power rails are also exported.

The figure below shows the pin assignment of the expansion header. With the exception of a few pins, most of the Expansion Header's pins are the same as those on the EFM32 Gecko or EFM32 Tiny Gecko starter kits.

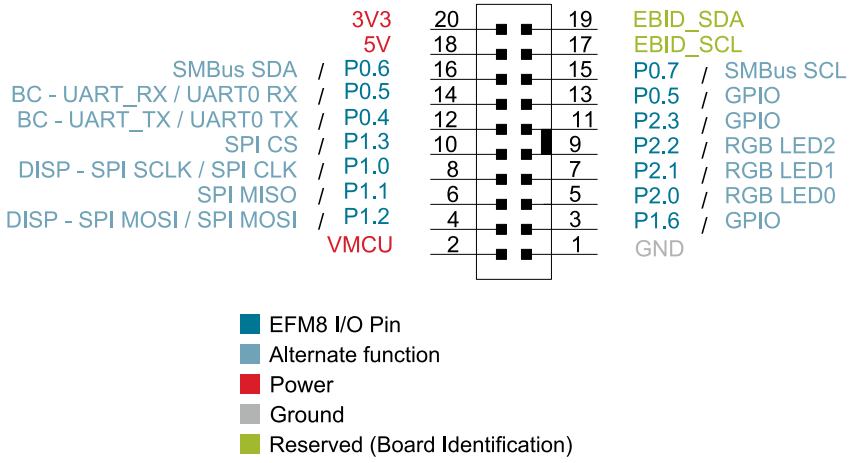

3V3 20
5V 18
SMBus SDA / P0.6 16
BC - UART_RX / UART0 RX / P0.5 14
BC - UART_TX / UART0 TX / P0.4 12
SPI CS / P1.3 10
DISP - SPI SCLK / SPI CLK / P1.0 8
SPI MISO / P1.1 6
DISP - SPI MOSI / SPI MOSI / P1.2 4
VMCU 2
19 EBID_SDA
17 EBID_SCL
15 P0.7 / SMBus SCL
13 P0.5 / GPIO
11 P2.3 / GPIO
9 P2.2 / RGB LED2
7 P2.1 / RGB LED1
5 P2.0 / RGB LED0
3 P1.6 / GPIO
1 GND
EFM8 I/O Pin
Alternate function
Power
Ground
Reserved (Board Identification)

Figure 6.2. Expansion Header

Some of the chip peripheral functions that are available on the Expansion Header are listed in the table below.

Table 6.1. Some peripheral functions available on Expansion Header

Peripheral	Peripheral pin	MCU Pin	EXP Header pin number
UART0	UART0 TX	P0.4	12
	UART0 RX	P0.5	14
SPI1	SPI1 SCK	P1.0	8
	SPI1 MISO	P1.1	6
	SPI1 MOSI	P1.2	4
	SPI1 CS	P1.3	10
SMBus	SMBus0 SDA	P0.6	16
	SMBus0 SCL	P0.7	15
PCA0	PCA0 CEX0	P1.1	5
	PCA0 CEX1	P1.6	7
	PCA0 CEX2	P1.7	9
ADC0	Input	Any supported pin (see Reference Manual for more information)	Multiple
	CNVSTR	P0.6	16
IREF0	Output	P0.7	15
Comparator 0	CMP0P Positive Input	Any supported pin (see Reference Manual for more information)	Multiple
	CMP0N Negative Input	Any supported pin (see Reference Manual for more information)	Multiple

Peripheral	Peripheral pin	MCU Pin	EXP Header pin number
Comparator 1	CMP1P Positive Input	Any supported pin (see Reference Manual for more information)	Multiple
	CMP1N Negative Input	Any supported pin (see Reference Manual for more information)	Multiple

Note: This table only sums up some of the alternate functions available on the expansion header. Consult the EFM8SB20F64G data sheet for a complete list of alternate functions.

6.3 Debug connector

This connector is used for Debug In and Debug Out (see chapter on Debugging).

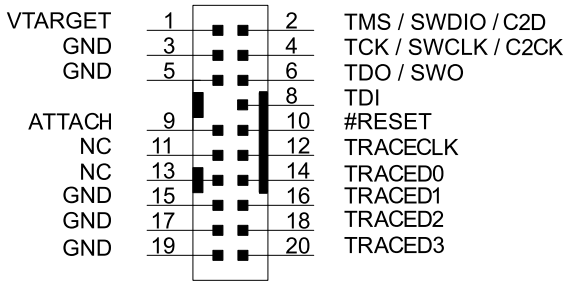


Figure 6.3. Debug Connector

Table 6.2. Debug connector pinout

Pin number	Function	Note
1	VTARGET	Target voltage on the debugged application.
2	TMS/SWDIO/C2D	JTAG TMS, Serial Wire data I/O, or EFM8 C2 data I/O
4	TCK/SWCLK/C2CK	JTAG TCK, Serial Wire clock, or EFM8 C2 clock
6	TDO/SWO	JTAG TDO or Serial Wire Output
8	TDI	JTAG data in
9	Cable detect	This signal must be pulled to ground by the external debugger or application for cable insertion detection.
10	#RESET	Target MCU reset
12	TRACECLK	Trace clock
14, 16, 18, 20	TRACED0-3	Trace data (4 lines)
11, 13	NC	Not Connected
3, 5, 15, 17, 19	GND	

6.4 Direct debug connector

This connector is used for directly debugging the EFM8 using an external debug adapter (see chapter on Debugging). This is especially useful for debugging the MCU on the STK board when the part is battery powered or powered by an external supply.

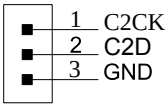


Figure 6.4. Direct Debug Connector

Table 6.3. Direct debug connector pinout

Pin number	Function	Note
1	C2CK	EFM8 C2 clock
2	C2D	EFM8 C2 data I/O
3	GND	

6.5 Reference board

The top-right corner of the board includes a 20-pin reference board connector. The connecter contains some I/O pins that can be used with some of the EFM8 EFM8SB2 Sleepy Bee's features. Additionally, the 3V3 and 5V power rails are also exported.

The figure below shows the pin assignment of the reference board header.

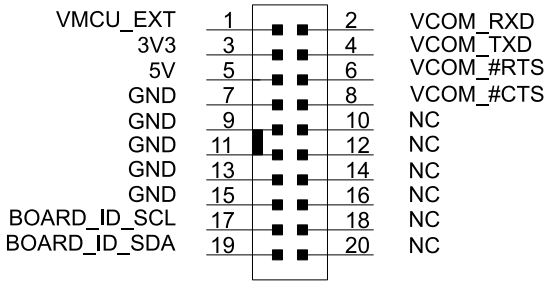

VMCU_EXT 1 2 VCOM_RXD
3V3 3 4 VCOM_TXD
5V 5 6 VCOM_#RTS
GND 7 8 VCOM_#CTS
GND 9 10 NC
GND 11 12 NC
GND 13 14 NC
GND 15 16 NC
BOARD_ID_SCL 17 18 NC
BOARD_ID_SDA 19 20 NC

Figure 6.5. Reference Board Header

7. Integrated Development Environment

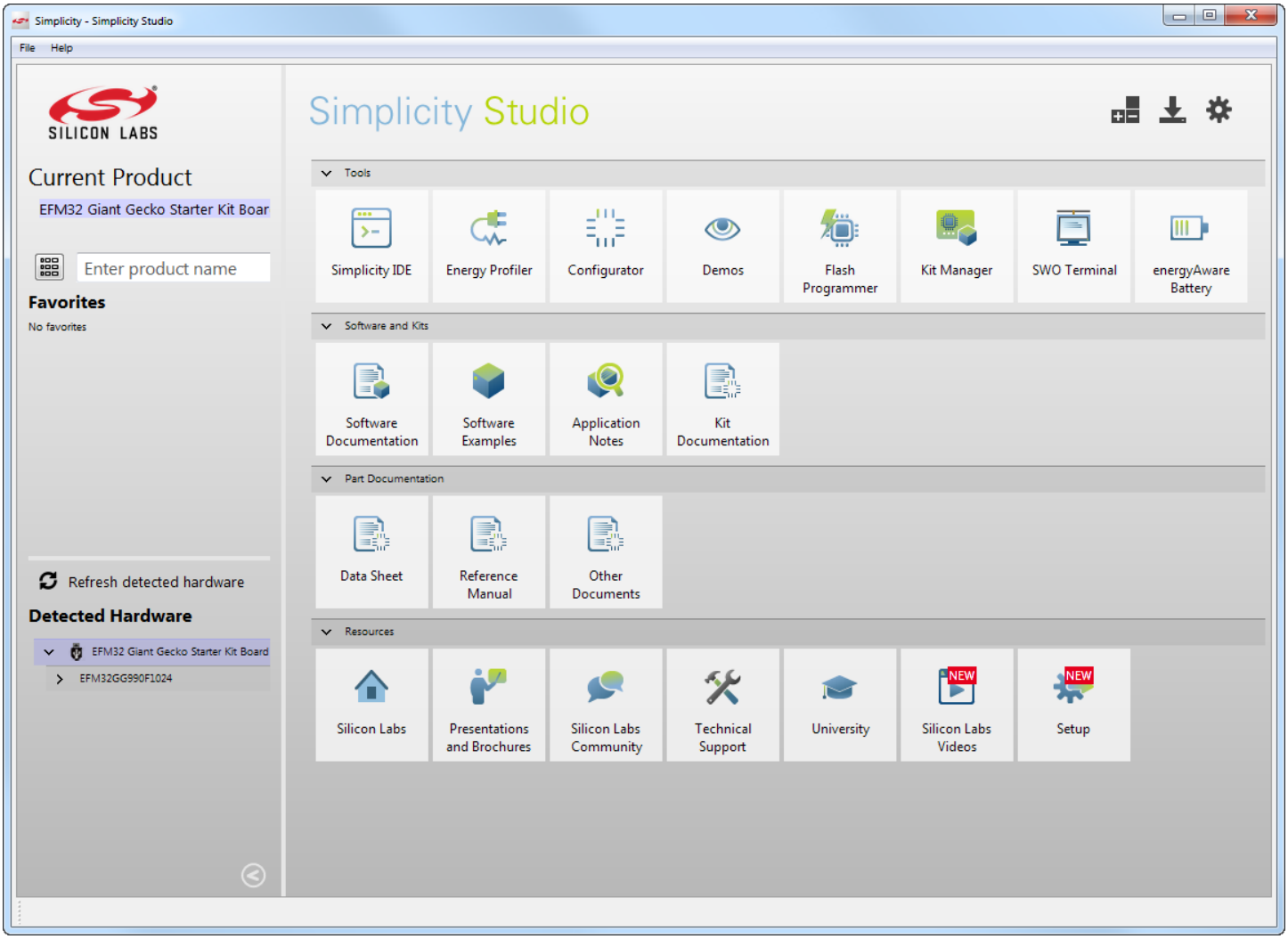


Figure 7.1. Simplicity Studio

Simplicity Studio includes various examples in source form to use with the Starter Kit. To run these examples:

1. Provide power to the board by connecting the DBG USB connector to the PC using the provided USB cable.
2. Move the switch to the AEM position.
3. Click the [**Refresh detected hardware**] button and select the EFM8SB2 Sleepy Bee Starter Kit Board kit under [**Detected Hardware**].
4. Click the [**Software Examples**] tile under [**Software and Kits**].
5. In the wizard, select the EFM8SB2 Starter Kit kit and click [**Next**].
6. Select the desired example or demo from the list and click [**Next**].
7. Click [**Finish**].
8. Click the [**Debug**] button in the IDE to build and download the code to the hardware.
9. Follow the instructions at the top of the main example file to set up the hardware as needed.
10. Click the [**Resume**] button to start running the example.

8. Advanced Energy Monitor

8.1 Usage

The AEM (Advanced Energy Monitor) data is collected by the board controller and can be displayed by the energyAware Profiler, available through Simplicity Studio. By using the energyAware Profiler, current consumption and voltage can be measured in realtime.

8.2 AEM theory of operation

In order to be able to accurately measure current ranging from 0.1 µA to 50 mA (114 dB dynamic range), a current sense amplifier is utilized together with a dual gain stage. The current sense amplifier measures the voltage drop over a small series resistor, and the gain stage further amplifies this voltage with two different gain settings to obtain two current ranges. The transition between these two ranges occurs around 250 µA. Digital filtering and averaging is done within the Board Controller before the samples are exported to the Energy Profiler application.

During startup of the kit, an automatic calibration of the AEM is performed. This calibration compensates for the offset error in the sense amplifiers.

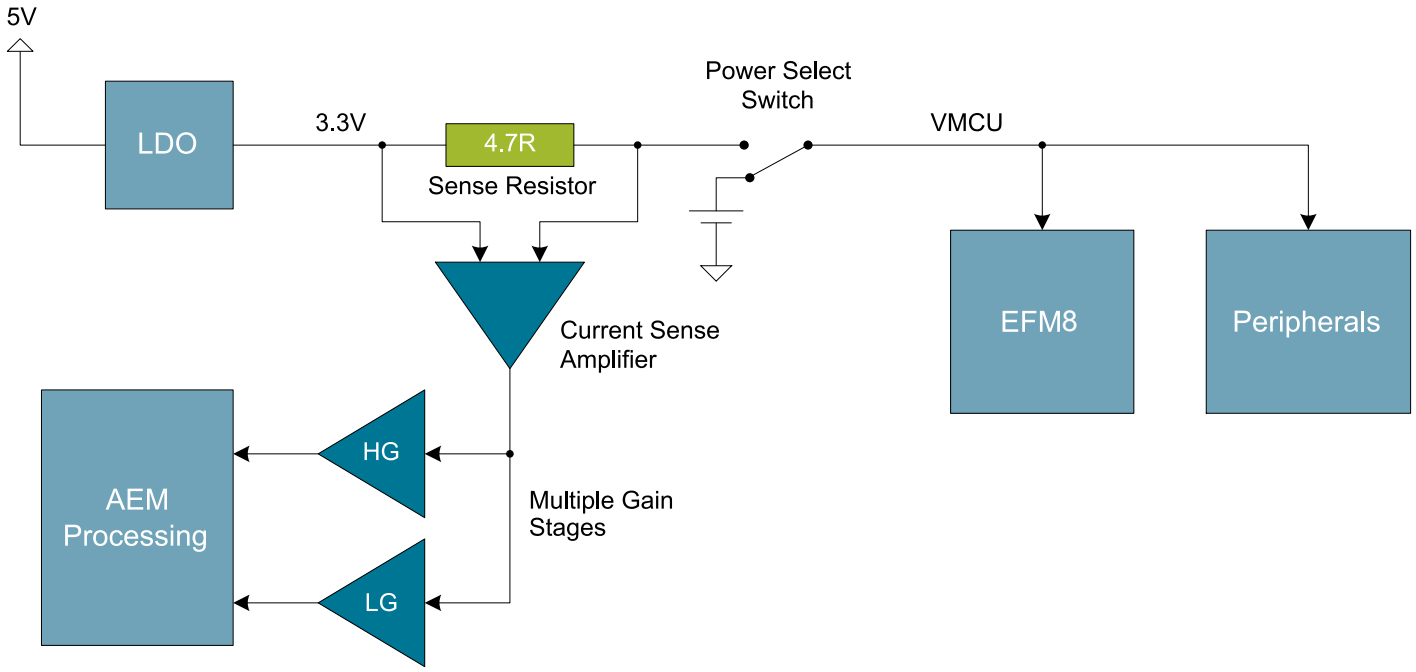


Figure 8.1. Advanced Energy Monitor

8.3 AEM accuracy and performance

The Advanced Energy Monitor is capable of measuring currents in the range of 0.1 µA to 50 mA. For currents above 250 µA, the AEM is accurate within 0.1 mA. When measuring currents below 250 µA, the accuracy increases to 1 µA. Even though the absolute accuracy is 1 µA in the sub 250 µA range, the AEM is able to detect changes in the current consumption as small as 100 nA. The AEM produces 6250 current samples per second.
Note: The current measurement will only be correct when powering the EFM8 from USB power through the debugger (power select switch set to DBG or AEM).

9. Board Controller

The kit contains a board controller that is responsible for performing various board-level tasks, such as handling the debugger and the Advanced Energy Monitor. An interface is provided between the EFM8 and the board controller in the form of a UART connection. The connection is enabled by setting the EFM_BC_EN (P1.4) line high, and using the lines EFM_BC_TX (P0.4) and EFM_BC_RX (P0.5) for communicating.

The BC enable signal connects the EFM8 to the board controller:

- 0: EFM8 UART pins are isolated from the Board Controller.
- 1: EFM8 UART pins are connected to the Board Controller (default upon reset).

Note: The board controller is only available when USB power is connected.

10. Debugging

The EFM8SB2-SLSTK2011A contains an integrated debugger, which can be used to download code and debug the EFM8SB2 Sleepy Bee EFM8 MCU. In addition to programming the MCU on the kit, the debugger can also be used to program and debug external Silicon Labs EFM8 devices.

10.1 Debug Modes

Programming external devices is done by connecting to a target board through the provided Debug IN/OUT Connector, and by setting the debug mode to [**Out**]. The same connector can also be used to connect an external debugger to the EFM8 MCU on the kit, by setting the debug mode to [**In**]. A summary of the different supported debug modes is given in Table 10.1 Debug modes on page 17.

Table 10.1. Debug modes

Mode	Description
Debug MCU	In this mode the on-board debugger is connected to the EFM8 on the EFM8SB2-SLSTK2011A.
Debug In	In this mode, the on-board debugger is disconnected, and an external debugger can be connected to debug the EFM8 on the EFM8SB2-SLSTK2011A.
Debug Out	In this mode, the on-board debugger can be used to debug an EFM8 mounted on a custom board.

Selecting the active debug mode is done with a drop-down menu in the Kit Manager tool, which is available through Simplicity Studio.

When using the debug adapter in the [**Out**] mode, the end device must be manually detected before debugging and programming. To do this:

1. Right-click on the kit from the Simplicity Studio launch screen and select [**Configure...**].
2. If needed, select the appropriate [**Target Interface**] for the external device. For example, EFM8 devices will use the [**C2**] selection.
3. In the same dialog, click the [**Detect Target**] button.
4. Click [**OK**] to close the dialog. The external target can now be debugged and programmed.

10.2 Debugging during battery operation

When the EFM8 is powered by battery and the J-Link USB is still connected, the on-board debug functionality is available. If the USB power is disconnected, the Debug In mode will stop working.

To enable debugging when the USB cable is removed, connect an external debugger to the MCU Debug Header in the top right corner of the EFM8SB2-SLSTK2011A instead of the Debug IN/OUT Connector. This header is connected directly to the EFM8's debug interface. The pinout of this header is shown in the Connectors chapter.

11. Kit Manager and Upgrades

The Kit Manager is a program that comes with Simplicity Studio. It can perform various kit and EFM8 specific tasks.

11.1 Kit Manager Operation

This utility gives the ability to program the EFM8, upgrade the kit, lock and unlock devices and more. Some of the features will only work with Energy Micro kits, while other will work with a generic J-Link debugger connected.

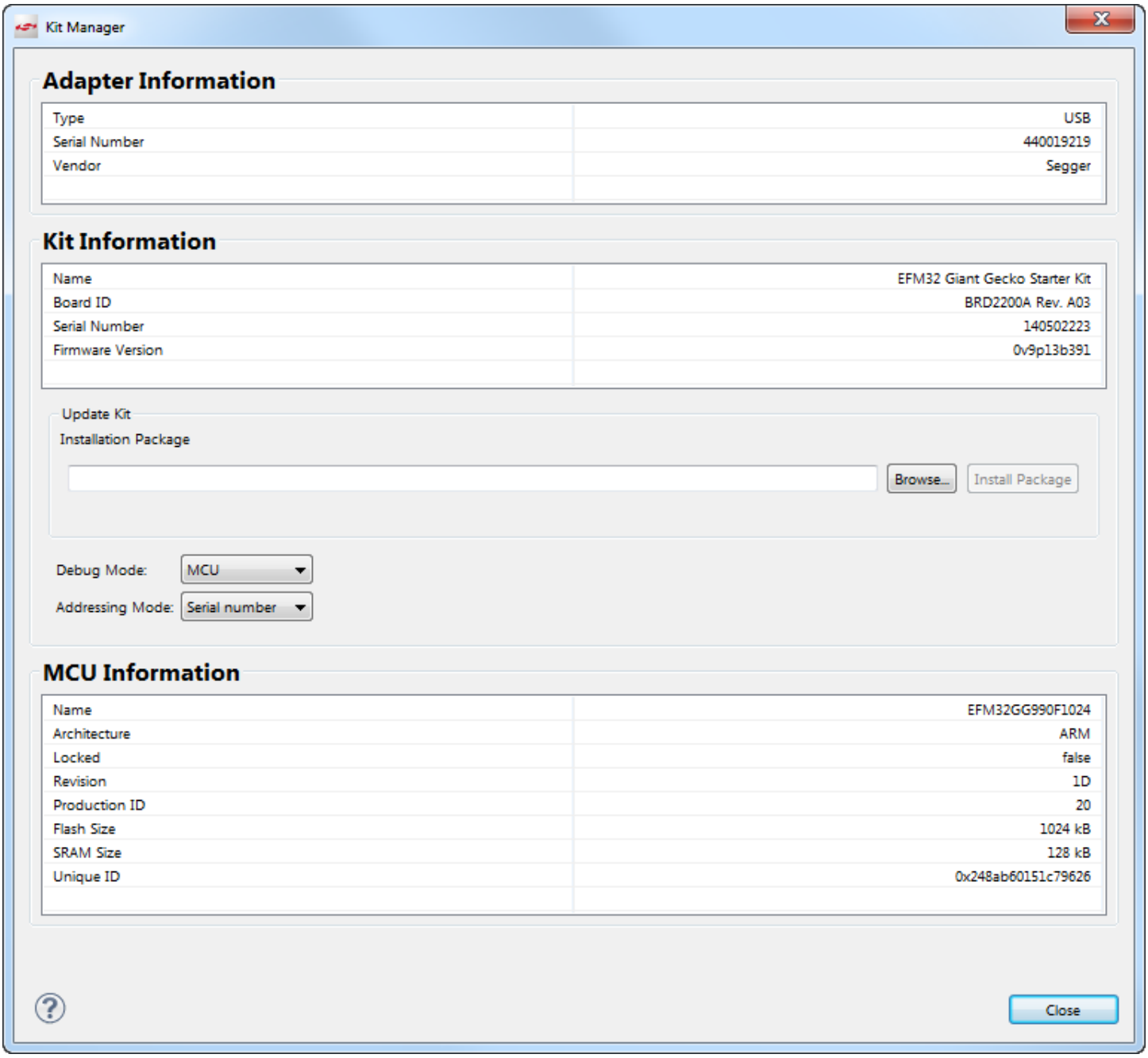


Figure 11.1. Kit Manager

11.2 Firmware Upgrades

Upgrading the kit firmware is done through Simplicity Studio. Simplicity Studio will automatically check for new updates on startup.

You can also use the Kit Manager for manual upgrades. Click the [**Browse**] button in the [**Update Kit**] section to select the correct file ending in ".emz". Then, click the [**Install Package**] button.

12. Schematics, Assembly Drawings and BOM

The schematics, assembly drawings and bill of materials (BOM) for the EFM8SB2 Starter Kit board are available through Simplicity Studio when the kit documentation package has been installed.

Simpilcity Studio

One-click access to MCU tools, documentation, software, source code libraries & more. Available for Windows, Mac and Linux!

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